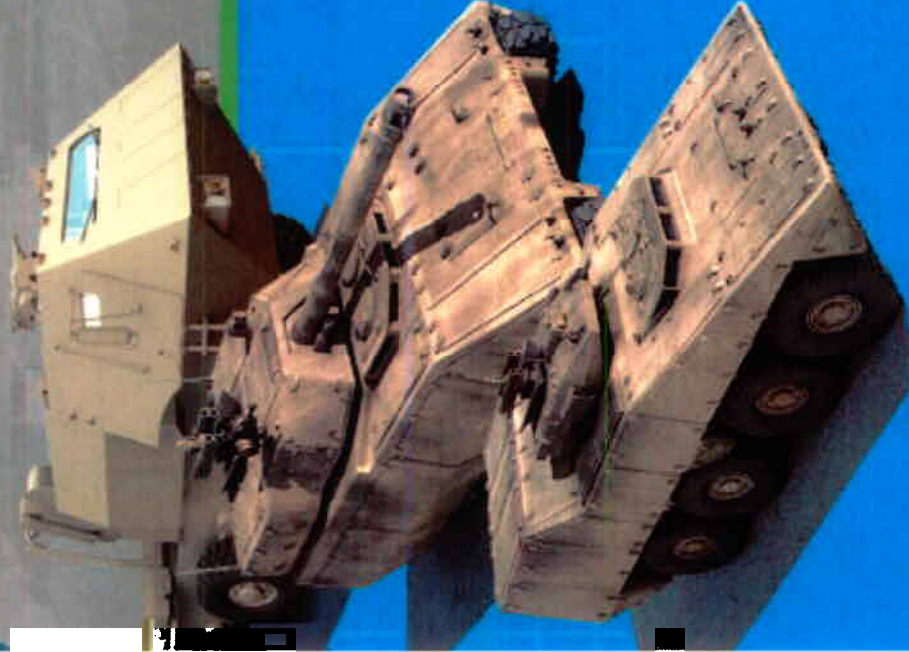


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Thermal Imagine Applications Toward Design Optimization and Operational Troubleshooting of Lightweight Robotic Vehicles

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&
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GVSS, Redondo Beach, California
29 March 2006



TARDEC
U.S. ARMY TANK-AUTOMOTIVE RESEARCH DEVELOPMENT AND ENGINEERING CENTER

SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

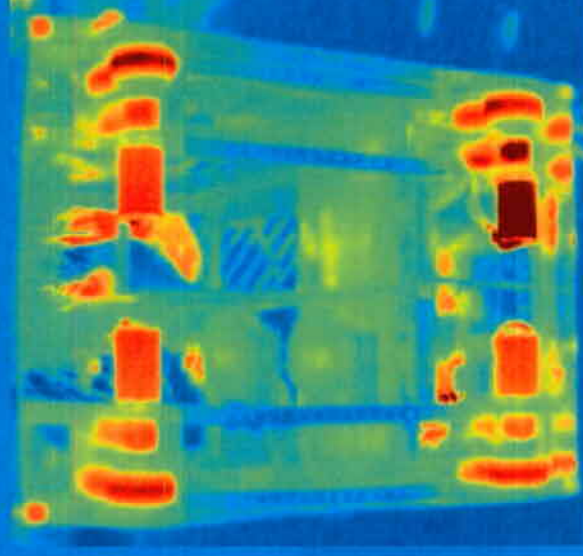
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Introduction

SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

- Table of Contents
- Background
- FIRST-Competition Description
- Process Improvement
- Results
- Summary



Purpose

SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

- Annotate a method employing thermal imaging devices to identify potential mechanical/electrical failure modes and validate system design of unmanned ground vehicles
- End Result:
 - Improved reliability and durability of unmanned ground vehicles
 - Improve system design by identifying overworked components
 - Identify components with failure modes during preventative maintenance checks and services

Background

SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

- TARDEC Outreach
 - Ecybermission (<http://www.ecybermission.com/>)
 - Explorer Post 1928 (<http://www.scouting.org/>)
 - Mini Baja Competition (<http://www.sae.org/>)
 - Intelligent Ground Vehicle Competition
 - First Robotics Competition (<http://www.usfirst.org/>)
- First Robotics Competition
 - Objective: to inspire high school students to pursue a career in science and technology
 - Goals: Robots compete to finish a given scenario
 - Governance: Standardize rule for all competitors

First Robotics Competition

SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

A multinational competition that teams the scientist and engineers of tomorrow with professionals to solve engineering design challenges

- Standard kit of parts
- Six week time frame
- More than 28,000 high school participates in 2006



Engineering

Process Improvement

SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

TARDEC Engineers' fielded the Groves Robot to the competition

- TARDEC Engineer decided to have a Technology Demonstration of a Forward Looking InfraRed (FLIR) device (Detects hot spots)

- The FLIR was used for design reviews of student's robots

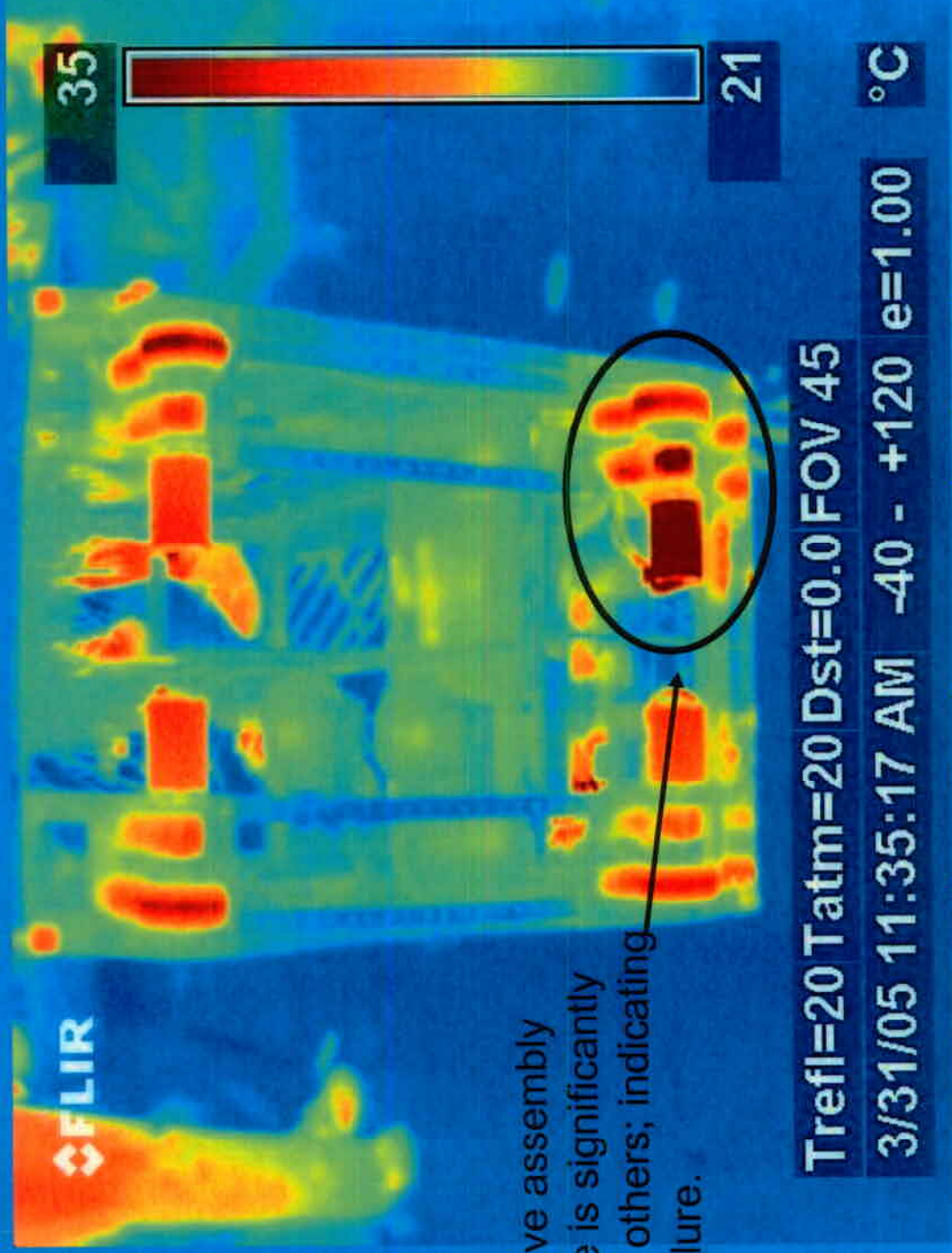
- Identifying areas of concern for each group
- Identified a potential failure for the

Groves Robot



Drive Assembly Results

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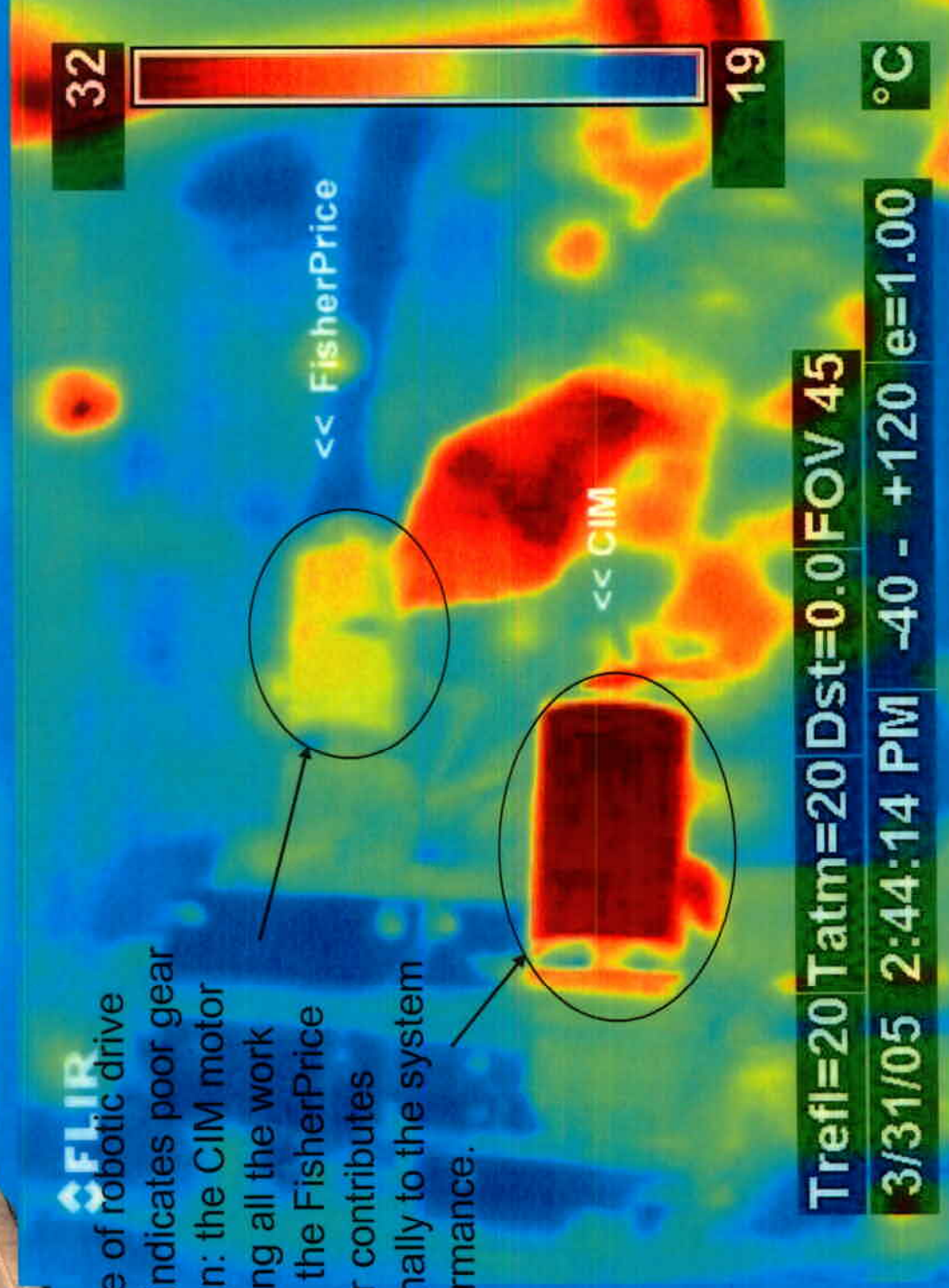


System Design Analysis

SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

FLIR

Image of robotic drive train indicates poor gear design: the CIM motor is doing all the work while the FisherPrice motor contributes minimally to the system performance.



Methodology

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FLIR Technology

- Technology demonstration turned into powerful tool.
- Able to diagnose failure modes before component failed during competition
- Components sometimes fail during match
- This method allowed to foresee possible failure
- Components replaced or design changed to lower failure possibility
- FLIR devices detected hot spots
 - Hot spots indicated more work being done (e.g. extra heat generated by extra friction)
- FLIR can be used to change designs to reduce the hot spots

Applying FLIR Process

SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

- Critical Elements to apply FLIR technology Failures Modes:
 - Quantified normal system operating conditions
 - Operating temperatures for motors, drive line assembly, etc.
 - Analyze thermal imagery of Robot
 - Detect points of interest (Hot Spots)
 - Analyze conditions of environment
 - External factors (e.g. surface grades, surface friction)
 - Internal Factors (e.g. airflow blockage, etc.)
 - Compare hot spots with baseline system results

Application of Technology

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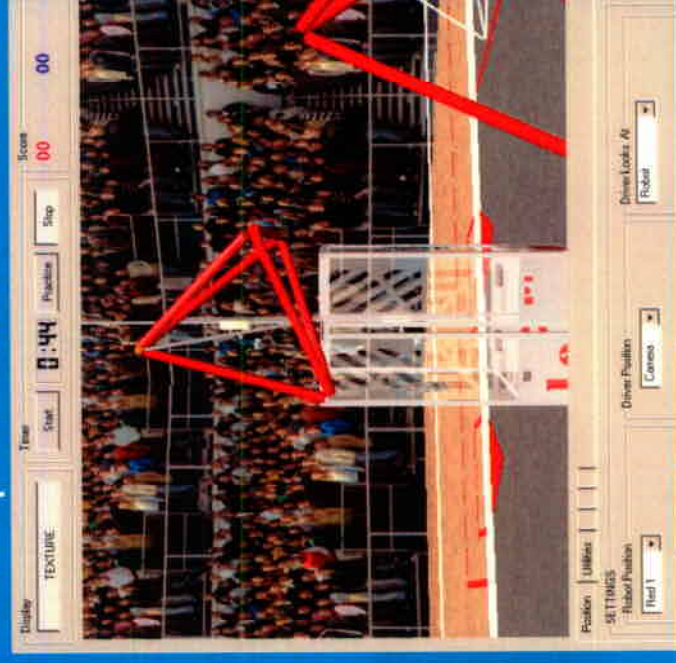
FLIR Imagery is used within the Army and industry for thermal management of various systems to include circuit design and thermal management of heat producing elements

- Video and IR data collect provides the engineer the operating conditions and system characteristics
- MuSES (Multi-Service Electro-optic Signature) software allows engineer to model thermal management of the system to include signature aspects
- Design changes are model to determine the impact on thermal management and signature of the system
- Identify design within the thermal management of the system before developed

Additional Developments

SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

- Developed Dual use technology
 - Initially developed by TARDEC and Student's to create a training environment to determine thermal profiles for competition tasks.
 - Now under review at STRICOM for its potential use in training



Summary

SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

- Application of Infrared device effect the unmanned system throughout various aspects of development:
 - Design: Optimize component and system design
 - Fielding: Identified failure modes before failures occur
- Application of a Simulator:
 - Produce thermal situation to identify potential failure modes
 - Identify thermal situational profiles to analyze system design
- Impact the reliability of unmanned ground vehicles

Questions

SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

“There are no foolish questions and no one becomes a fool until they have stopped asking questions.”

~ Unknown